Upper Hudson River Sedtran Model
Topic 4: Model Development

December 7, 2010

Objectives

- Summarize current model key parameters
  - Sediment classes definition
  - Initial bed properties distribution
  - Incoming sediment Load and composition
- Discuss future refinements to these parameters

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Current Model: Sediment Classes

- 1999 Model has two classes and unmovable bed
  - Silt and Clay
  - 90 µm
- 2010 Model defined with 4 classes

Class Limits	<62	62-250	250-2,000	> 2,000
Site Data	27	130-174	546-720	1,645-7,839
Model	30	90	1,500	8,000

Current Model
Bed Properties Spatial Distribution

- Non-cohesive bed
  - Use correlation between d_{50} and τ_N
    - d_{50} from Grain Size Distribution of 0-6” samples
    - τ_N for a 30,000 cfs flow. No significant sensitivity to flow
  - Composition based on correlation between d_{50} and fsus = f1+f2+f3
    - f1 = 10%, f4 = (1 – fsus)
    - f2 and f3 calculated based on the GSD means ratio
- Cohesive bed
  - Average d_{50} and composition

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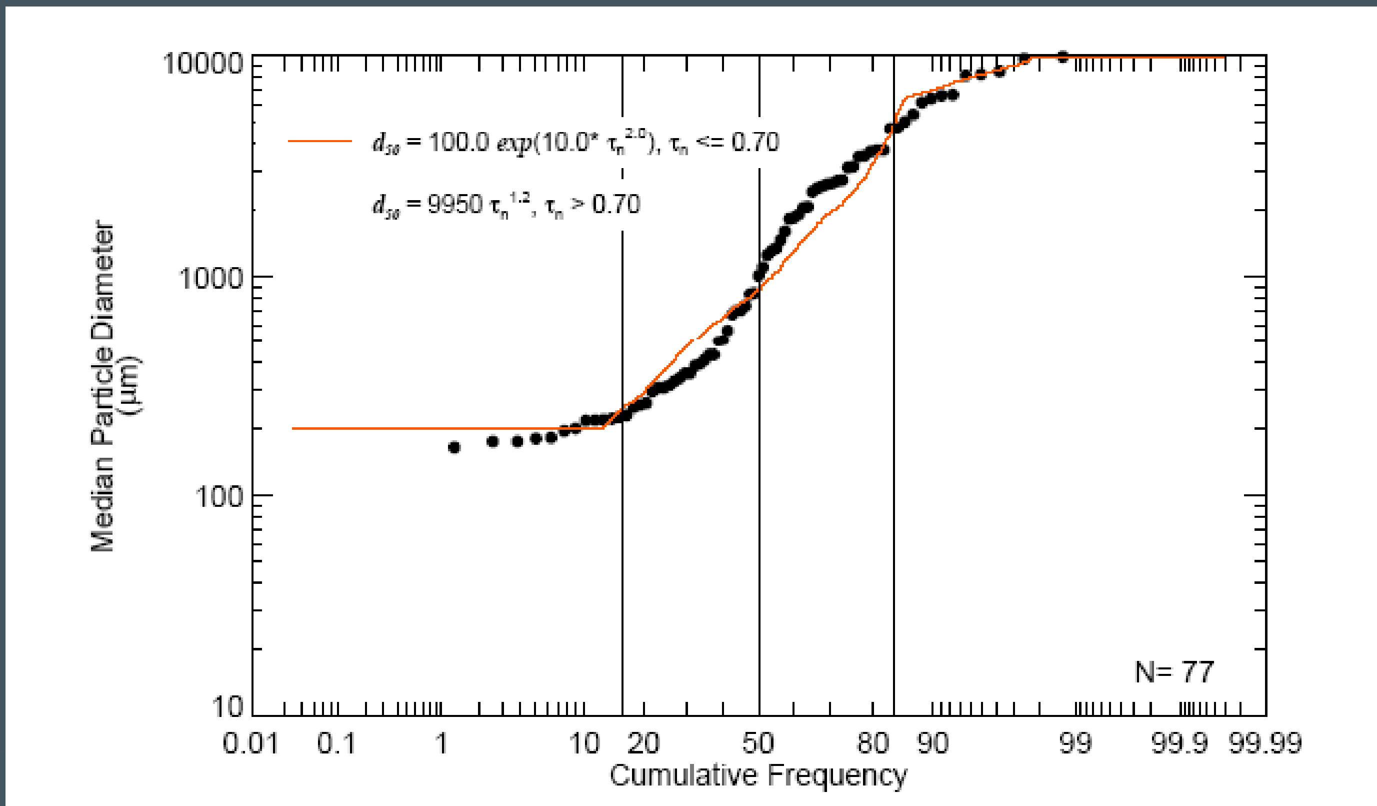
Current Model

Bed Properties Spatial Distribution

Comparison of predicted and measured distributions of D_{50} in Reach 8 (Figs. 5-10 ~ 5-12 in AQ report)



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Current Model: Incoming Load

- Same boundary conditions used in 1999 model
- Hudson River TSS
  - TSS Rating Curve at Fort Edwards incorporating hysteresis
  - Data when available
  - Composition
    - 25% of class 2 based on available USGS data
    - Constant for every flow

Current Model: Incoming Load

- Tributaries TSS
  - Rating Curve for Snook Kill and Moses Kill
  - All other tribs using following procedure:
    - Flow at each tributary was calculated using a flow balance with existing USGS flow gauges and the drainage area of each tributary
    - Annual average load at each tributary was calculated using a Sediment Mass balance between Fort Edwards, Stillwater and Waterford
    - Assume same equation for TSS rating curve
    - Calculate rating curve exponent based to honor annual average load
- Composition also constant except for Moses Kill and direct drainage

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Sediment Class Definition

- Refine 4 classes to improve effective particle diameter representation of each range

Class	1	2	3	4
Current	<62 µ	62-250 µ	250-2000 µ	> 2000 µ
Refinement	<62 µ	62-250 µ	250-850 µ	>850 µ

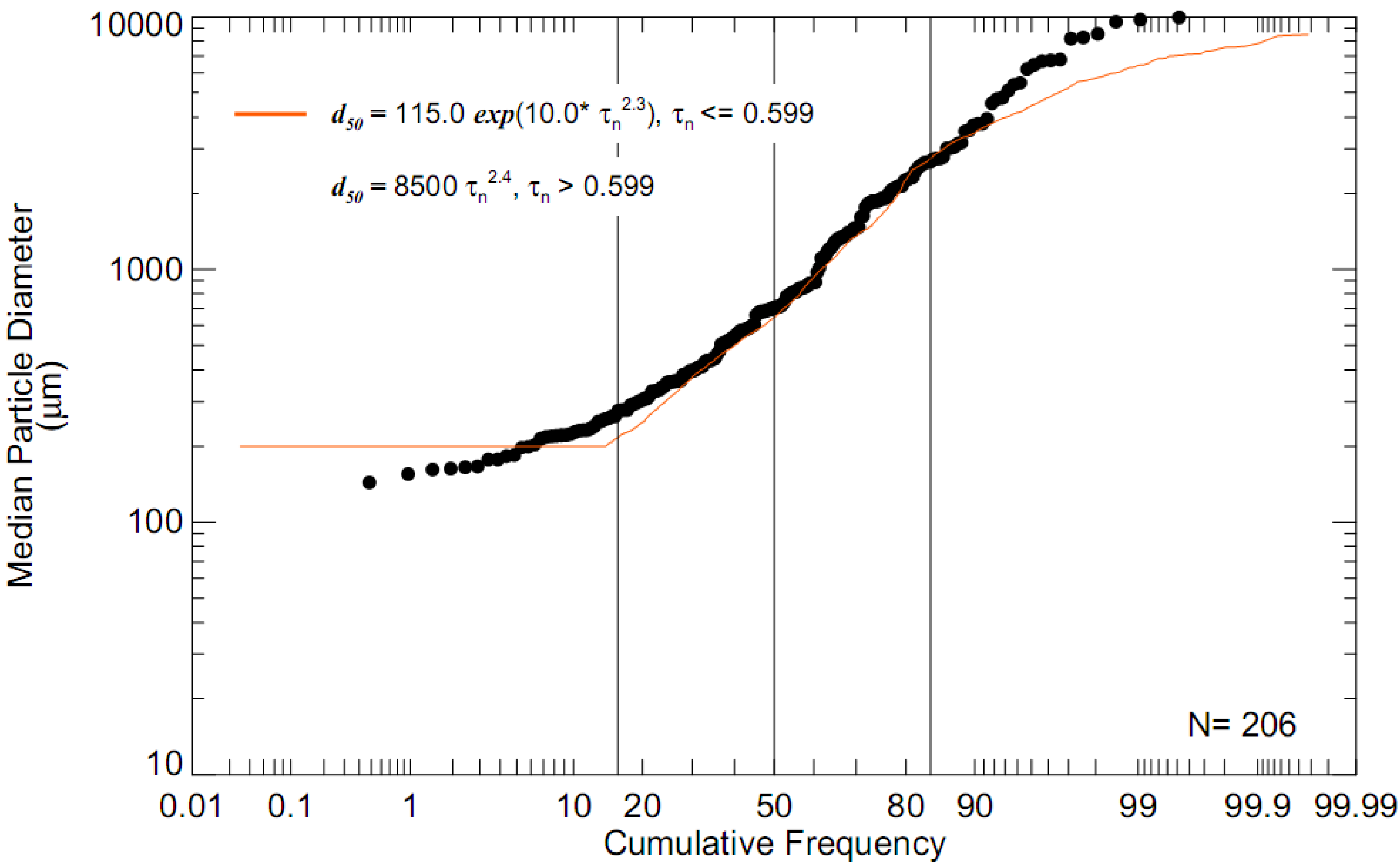
Bed Properties Definition

- Spatial distribution of d_{50} : 2 Approaches
  1. Using correlation between d_{50} and τ
     - Easier spatial interpolation
  2. Using correlation between d_{50} and bulk density
     - Makes use of more data
- Spatial distribution of initial composition
  - Use correlations between d_{50} and fractions

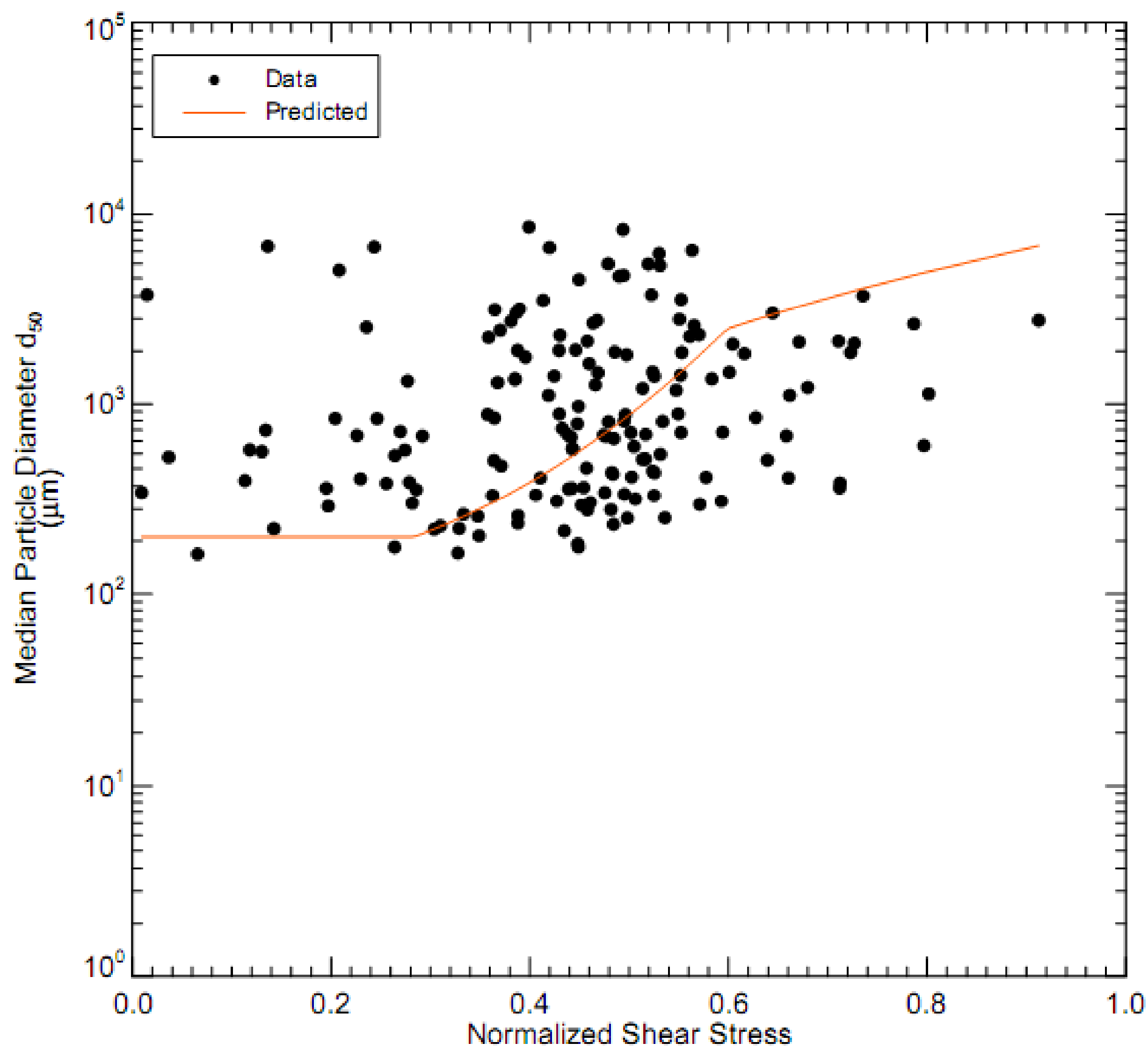
d_{50} Distribution: Approach 1 Description

- Use Grain Size Distribution (GSD) obtained for samples from 0-12”
  - About xxx samples for R8
- Reproduce the d_{50} probability distribution using a relationship between normalized τ and d_{50}
- Spread d_{50} using shear stress in the model domain
- Use data values for cells where samples exist and smooth transition to predicted values

d_{50} Probability Distribution



d_{50} vs Normalized τ



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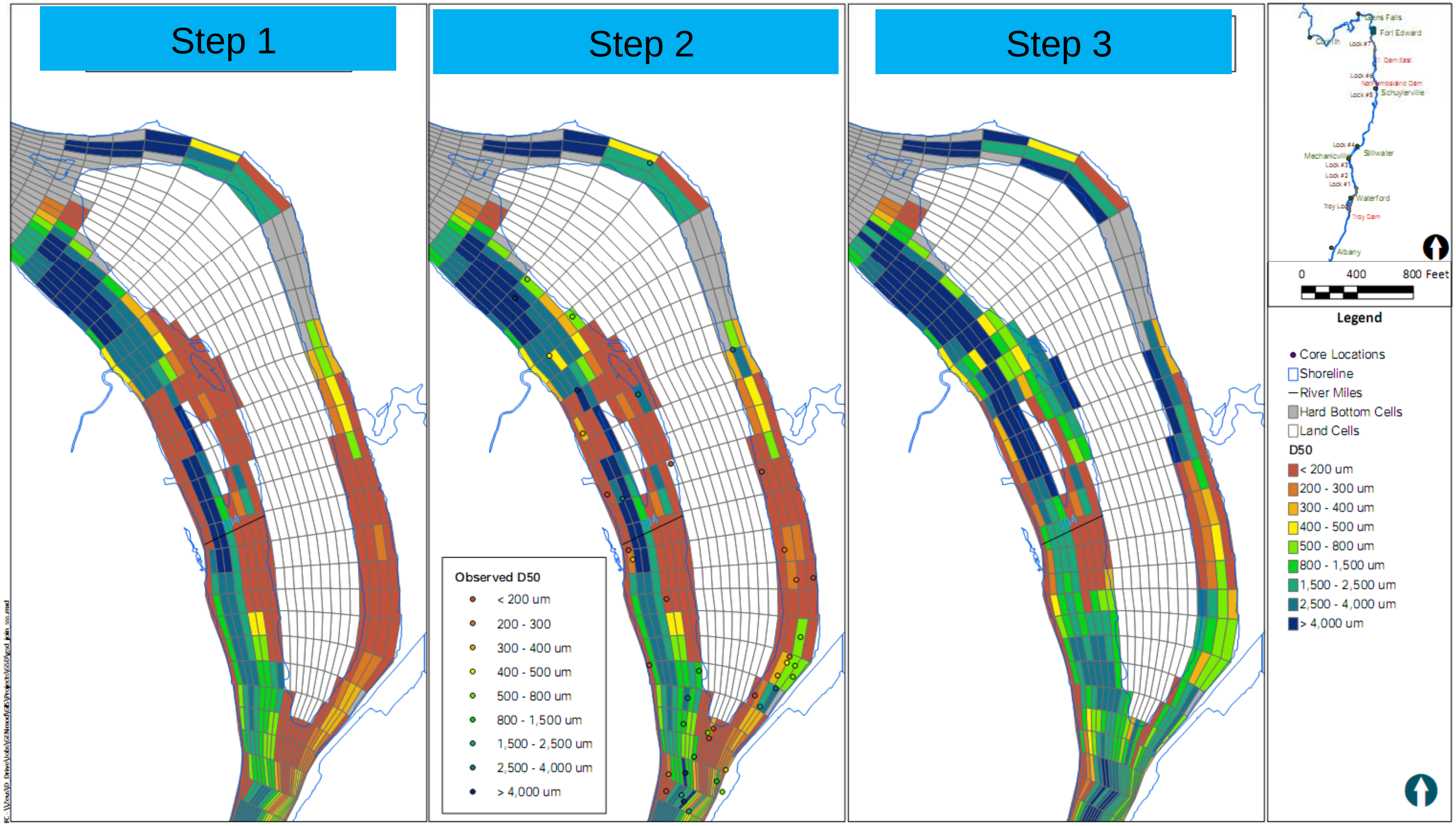
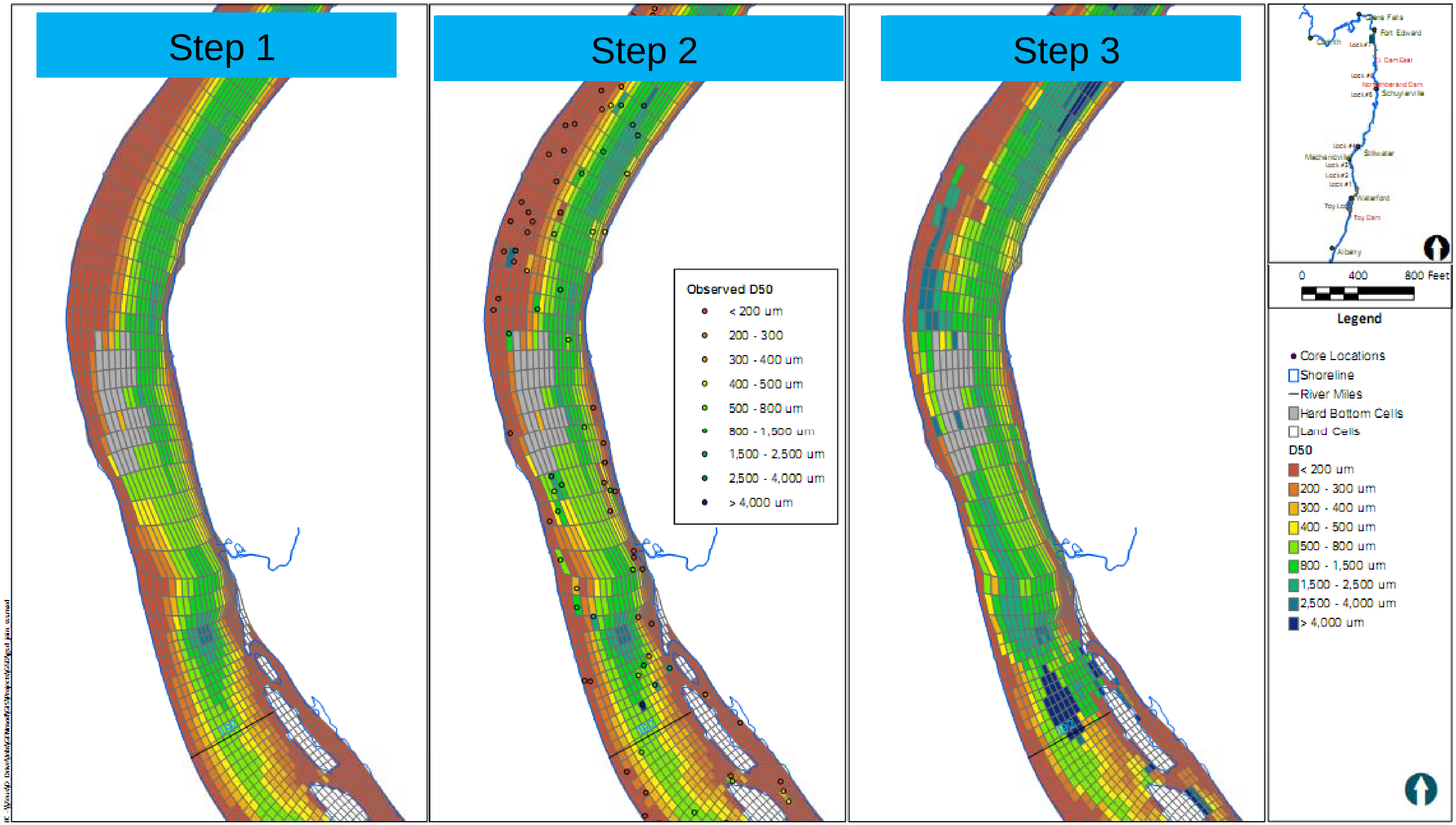
Approach 1 examples



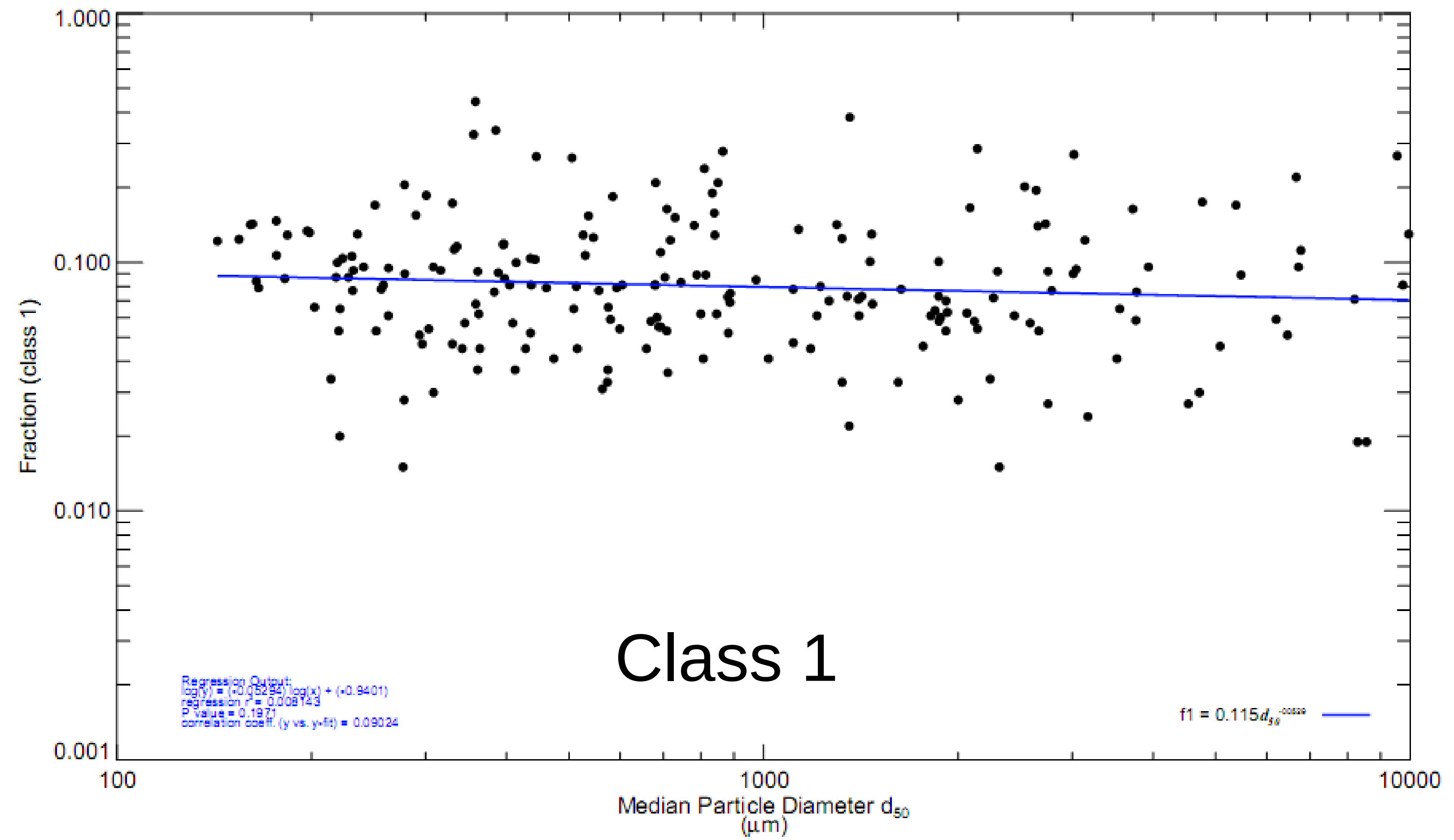
Approach 1 examples



d_{50} Distribution: Approach 2 Description

- John Wolfe presentation

Initial Bed Composition: Non-cohesive



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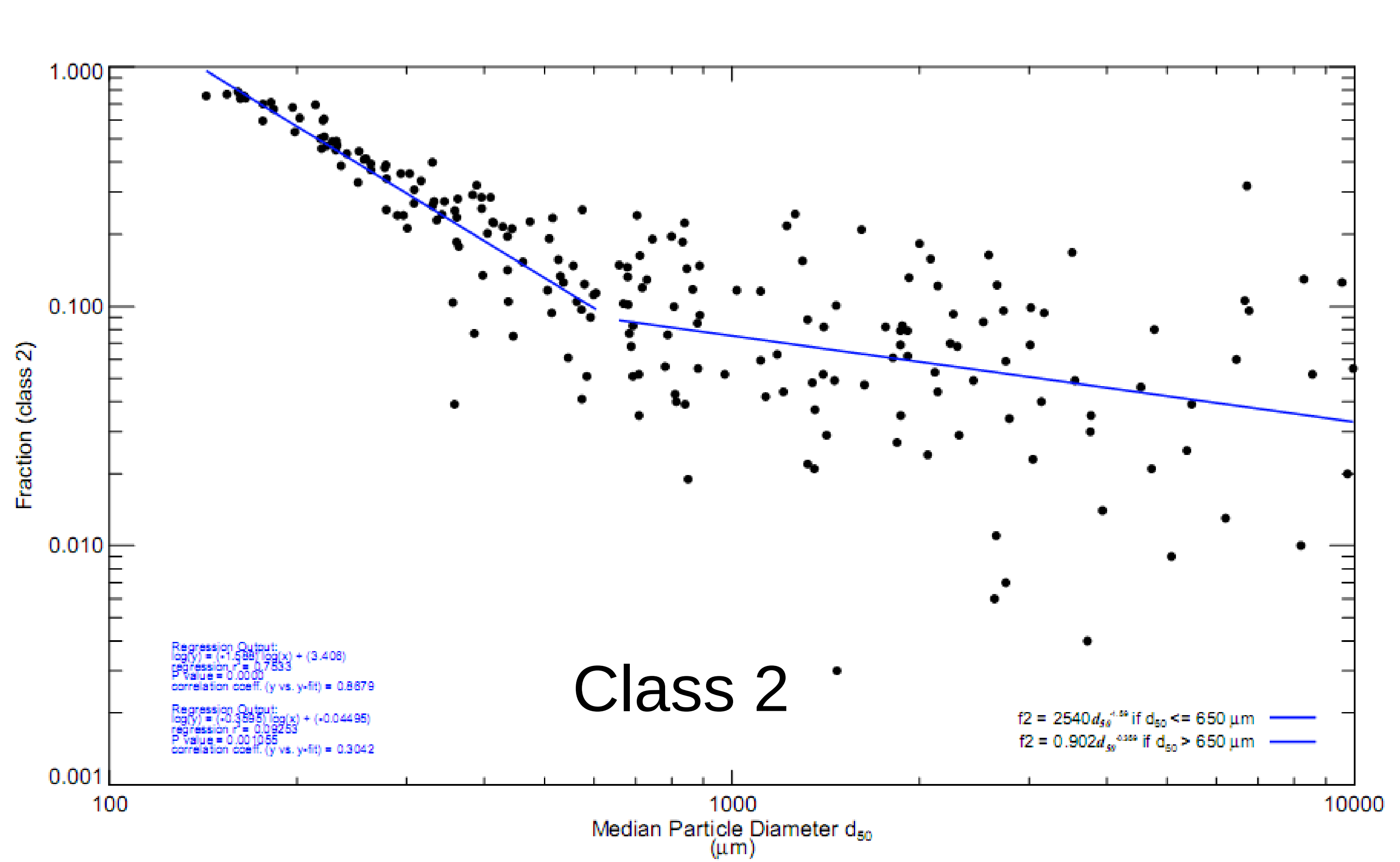
Initial Bed Composition: Non-cohesive



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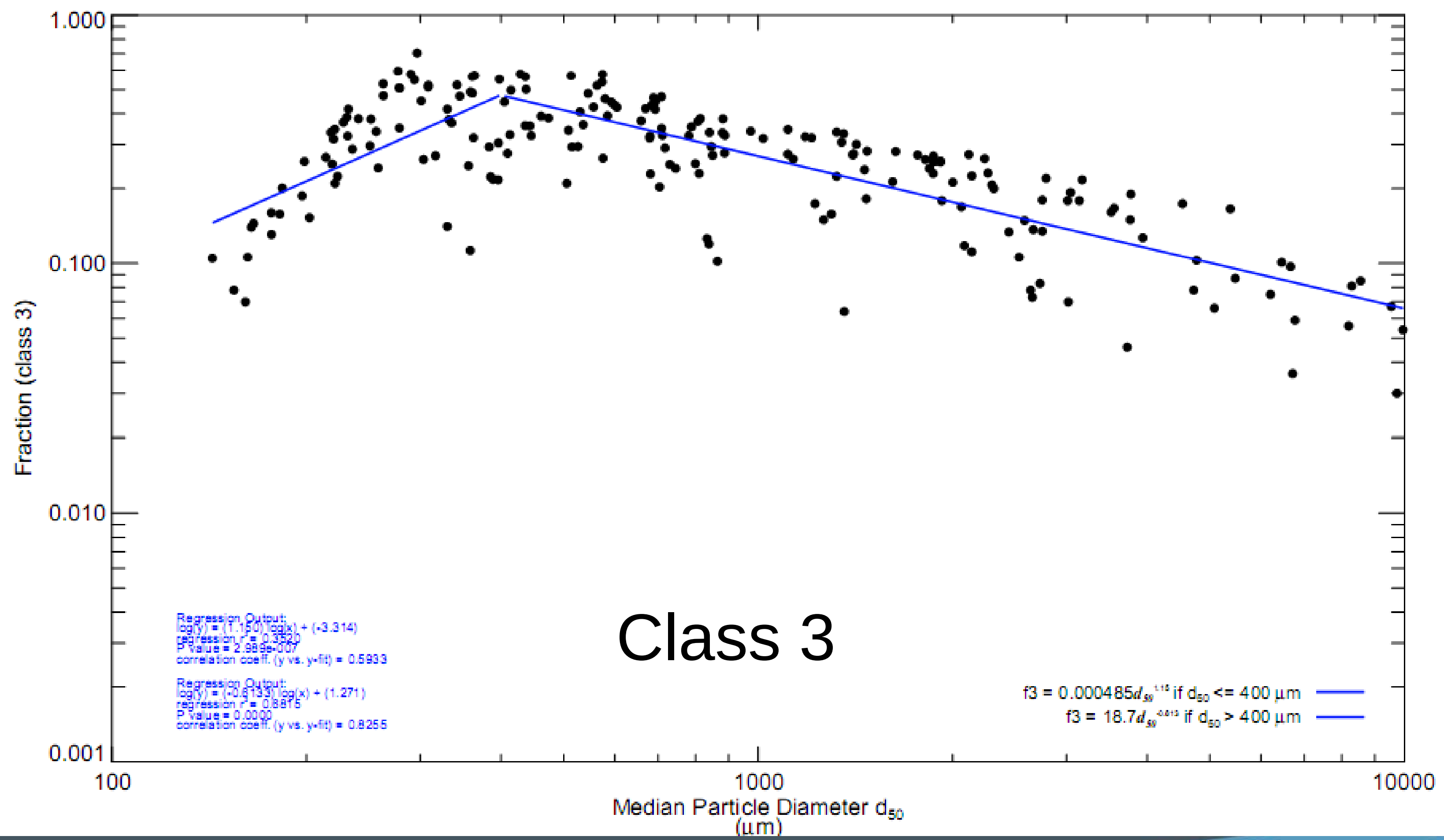

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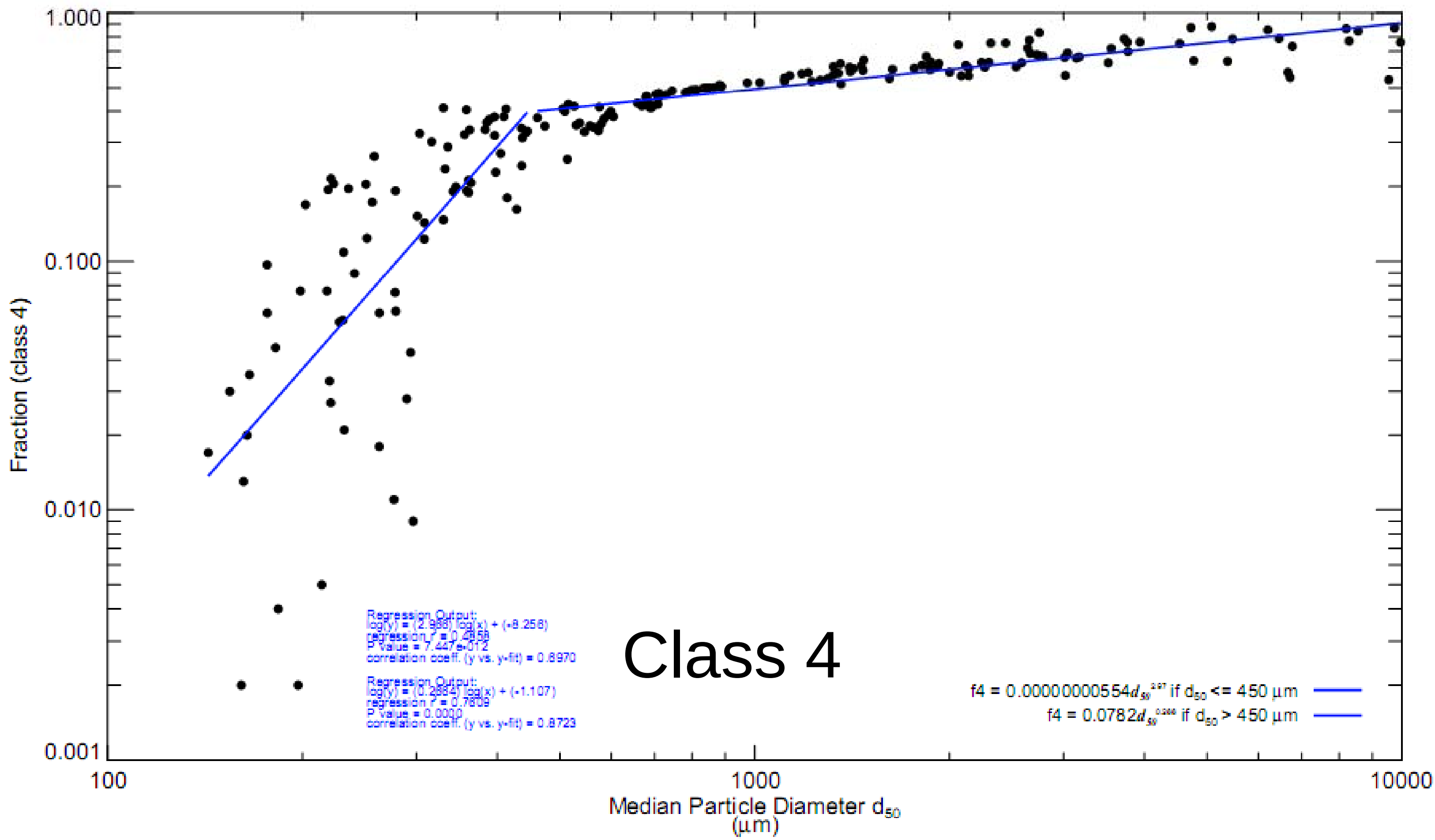

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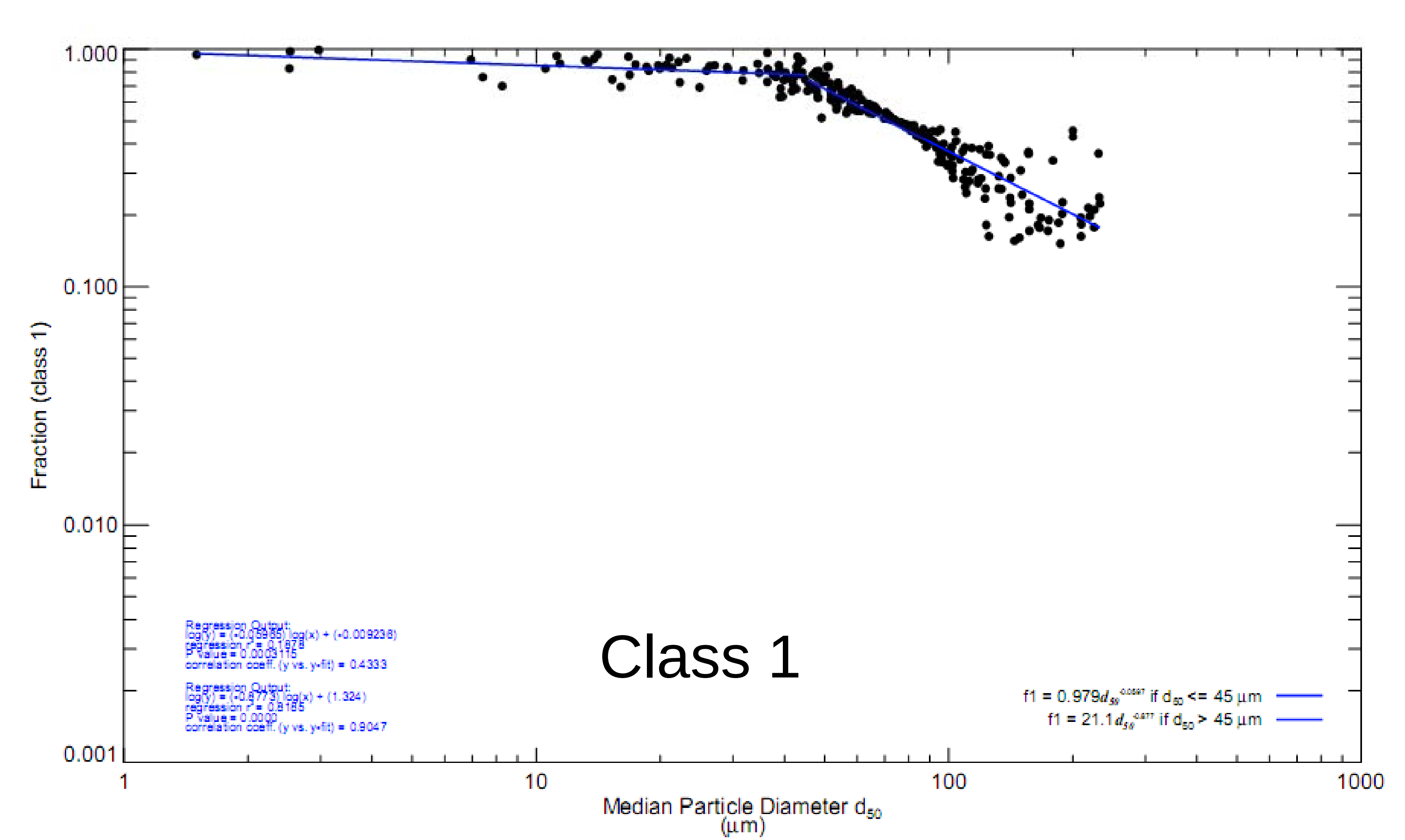
Initial Bed Composition: Proposed Procedure

- Use constant value for Class 1
- For d_{50} > ~450 μ
  - Use correlations to define fractions for Class 3 and Class 4
  - Assign the rest to Class 2
- For d_{50} < ~450 μ
  - Use correlations to define fractions for Class 2 and Class 3
  - Assign the rest to Class 4

Initial Bed Composition: Cohesive



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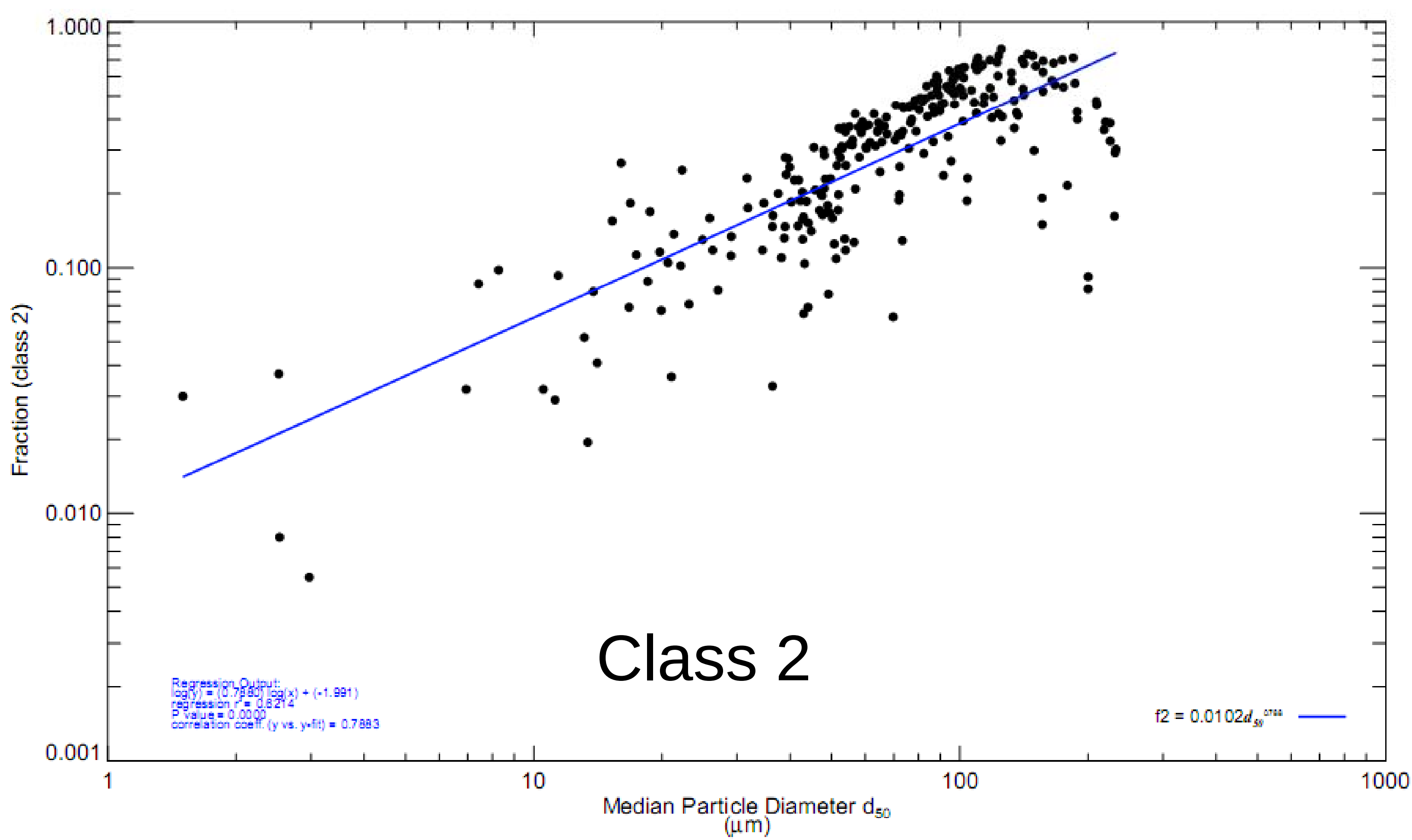
Initial Bed Composition: Cohesive



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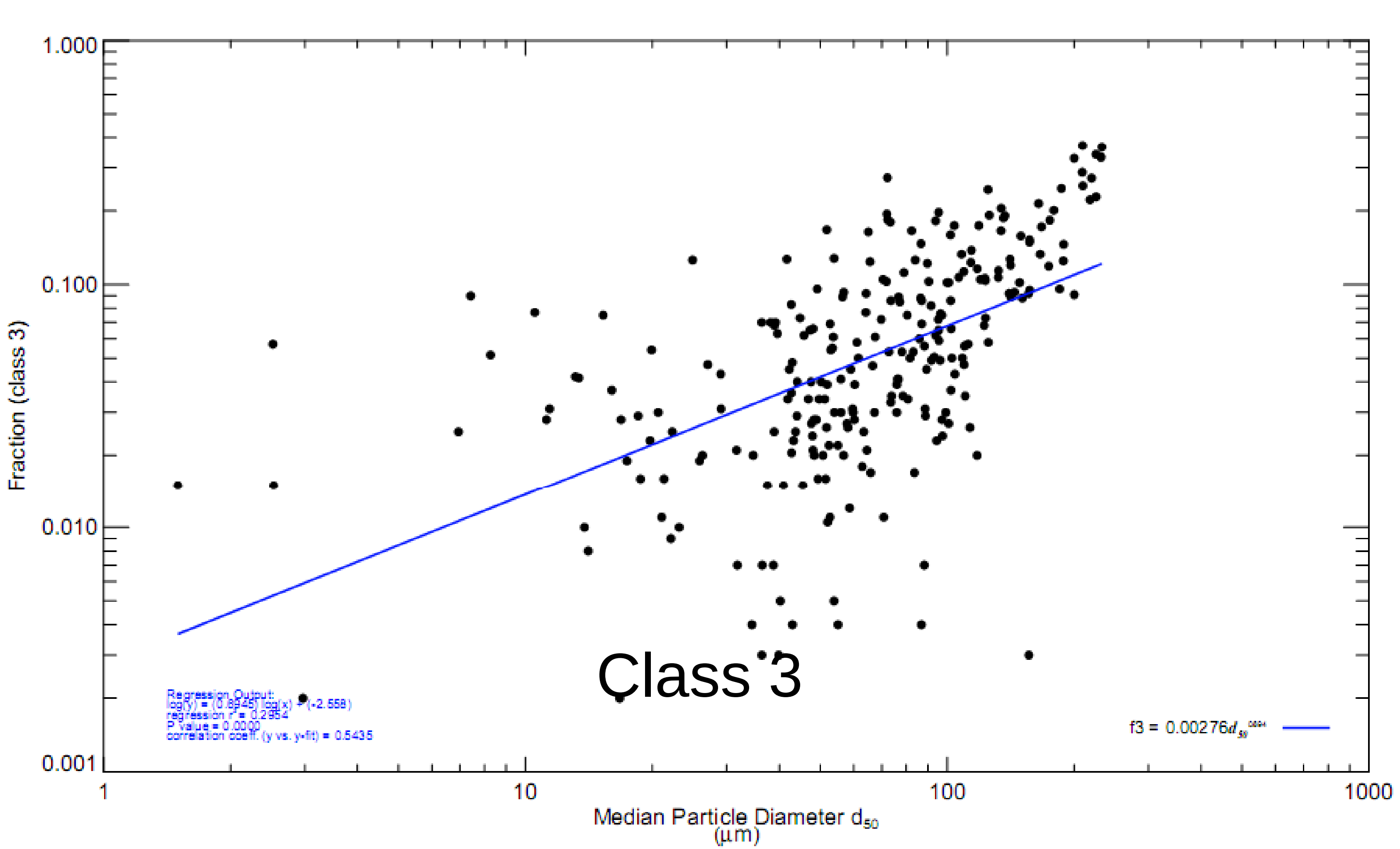

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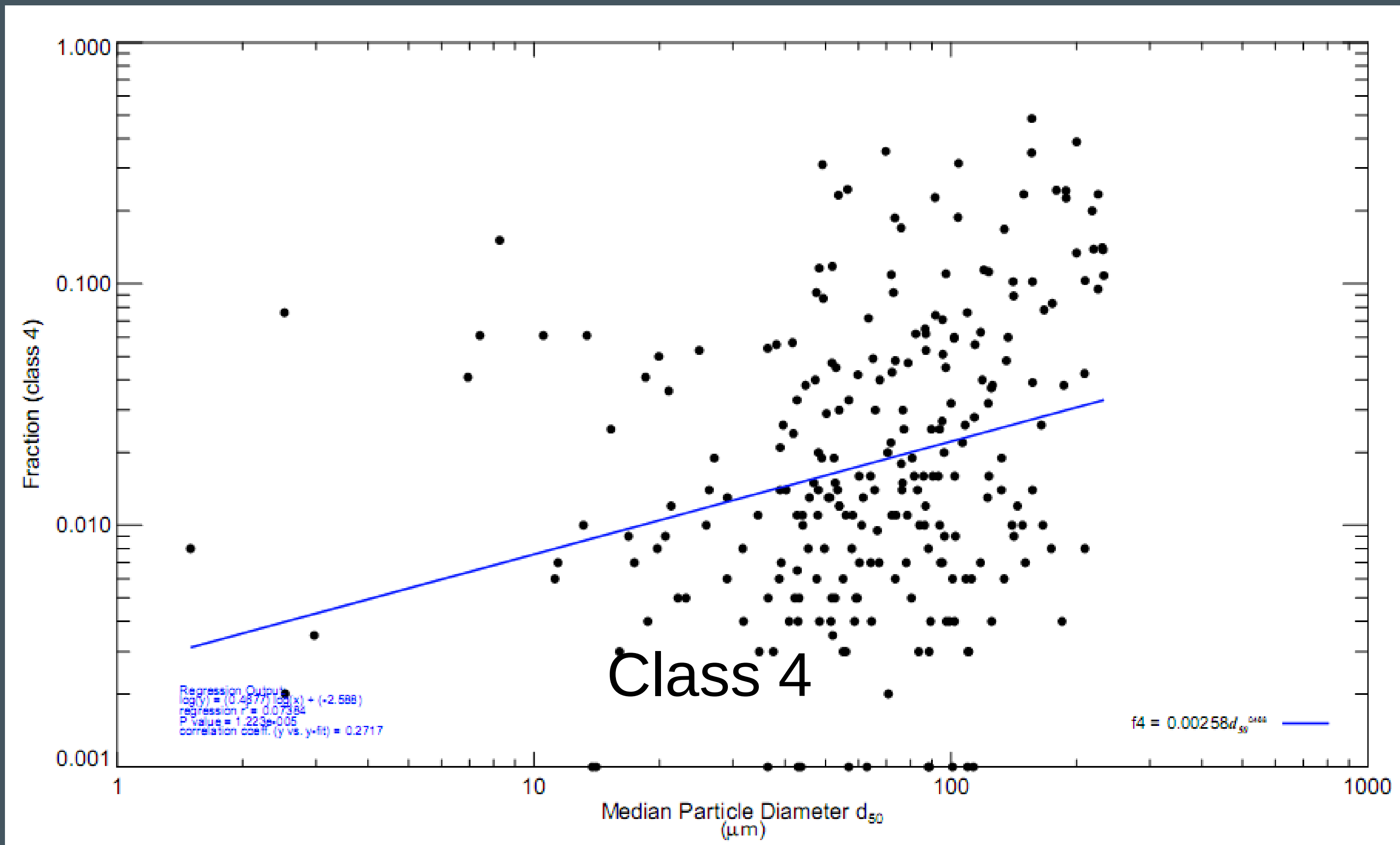
Initial Bed Composition: Cohesive



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Incoming Load Composition:
Proposed Procedure

1. Use bed composition and estimates of trapping efficiency of each class to calculate long term average incoming composition
2. Generate a rating curve for each incoming class honoring the composition calculated in Step 1

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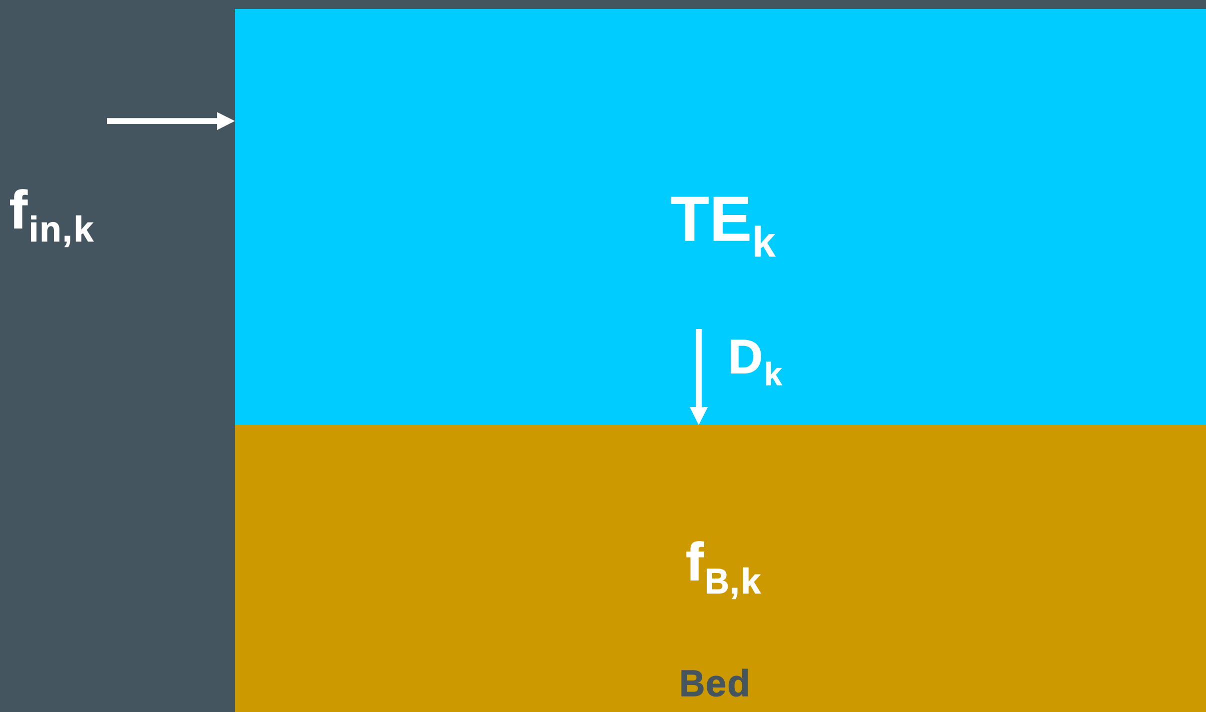
Incoming Load Composition



Incoming Load Composition

- Assuming: $f_{B,K} = \dfrac{D_K}{D_{TOT}}$, then

$$F_{IN,K} = \left(\frac{TE_{TOT}}{TE_K}\right) f_{B,K}$$ ← longterm average

where, $f_{B,K}$ = average bed content for class K

$F_{IN,K}$ = long term average of incoming load for class k

D_{TOT} = total deposition mass

D_K = deposition mass for class k

TE_{TOT} = total trapping efficiency

TE_K = trapping efficiency for class k

Incoming Load Composition

- Assuming temporal incoming composition as:

$$f_{IN,K} = \alpha_K \left(\frac{Q}{Q_{cr,k}}\right)^{n_K} \qquad Q > Q_{cr,k}$$

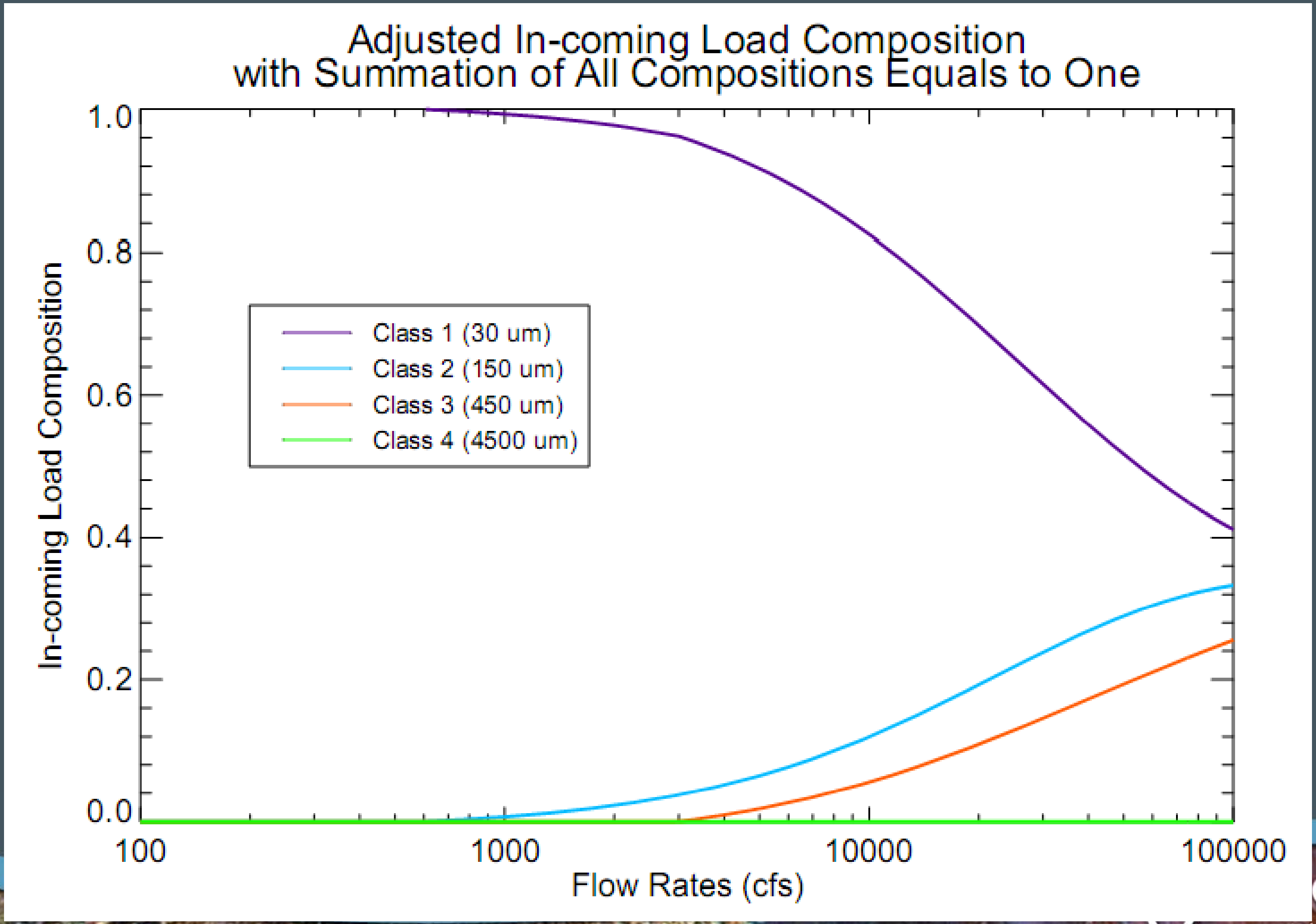
$$= 0 \qquad Q \leq Q_{cr,k}$$

- Adjust α and n until:

$$F_{IN,K} = \frac{1}{T}\int_0^T f_{IN,K}(Q)\,dt$$

Incoming Bed Composition - Example

Target Composition: 80% C1, 14% C2 and 6%C3



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